EFFECTS OF LIVESTOCK GRAZING ON A COMMUNITY OF SPECIES AT RISK OF EXTINCTION IN THE SAN JOAQUIN VALLEY, CALIFORNIA

Annual Report[1]

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Summary

We completed the third year of plant and animal censuses on the Lokern Natural Area study site, and the effects of the 1997 wildfire have lessened, while treatment plots received a second year of grazing by cattle. Cattle grazing is beginning to have a major effect on grass cover on treatment plots, although we are planning to increase grazing treatment in the fourth year of the study. Plant and bird studies continue with no significant effect of treatment visible at this early stage of the research. Lizard numbers continue to be extremely low throughout the study area. Nocturnal rodents are starting to become abundant on some plots, but it may take several more years to determine if grazing treatment is having any effect. San Joaquin antelope squirrels are also more abundant, and numbers were substantially greater on treatment plots than controls in 1999. We will continue to gather information on the year-to-year variation in rainfall, plot condition, and relative abundance of plants and animals. As population numbers of focused species increase across the study area and as the grazing treatment increases with time, it will become possible to develop a better understanding of grazing effects. If this study is to succeed it will take time, patience, and resources. Beginning in the year 2000, the field research on the Lokern will require $65,000 per year. This assumes that in-kind support from cooperating agencies and organizations will continue at past levels.

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Background

In 1995, the Bureau of Land Management (BLM) approached the US Geological Survey (then the National Biological Service) for assistance in developing a research project to help determine how livestock grazing on arid public lands in the southwestern San Joaquin Valley might be impacting several plant and vertebrate species that were listed by state and federal agencies as threatened or endangered. The Western Ecological Research Center (WERC) of the Biological Resources Division developed a research proposal to carry out the research in cooperation with several other agencies and organizations interested in the topic (see Cooperator's section below).

In 1997, a study site on the Lokern Natural Area in western Kern County was chosen and prepared for the research. This included fencing eight plots (Figure 1), four controls (62

acres or 29 hectares) each nested within four treatment pastures (one Section each or 640 acres or 259 hectares). Water was piped into each treatment plot for the cattle.

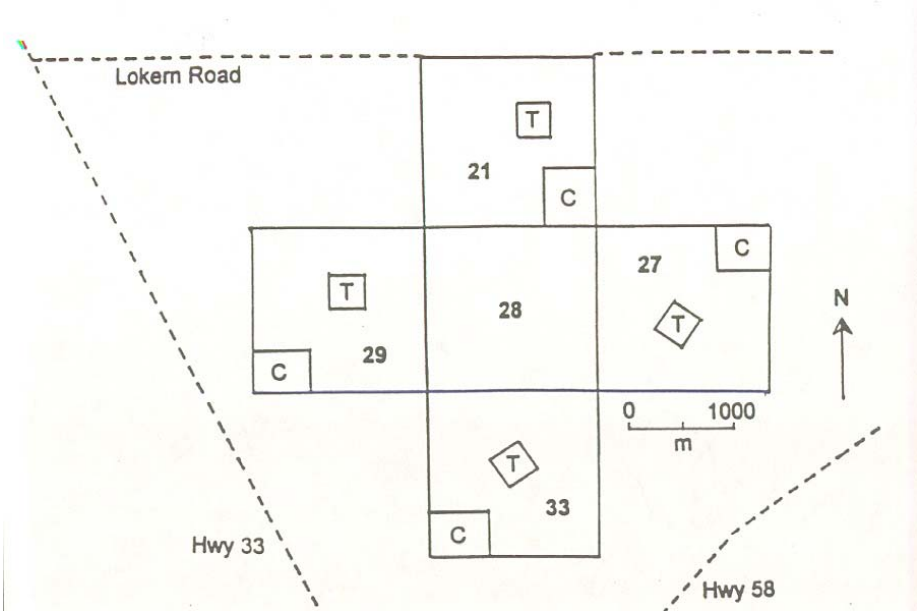

Figure 1. Lokern Study Area showing design of experimental and control plots.

Midway through the construction of cattle fencing in May 1997, an accidental wildfire burned through half of the study area. In order to reduce the confounding effect of this fire on the study design, the other half of the study area was intentionally burned in July 1997. Initial, baseline plant sampling was completed on the four treatment and four control plots before the burns in 1997, while baseline vertebrate sampling was completed on the eight plots after the burns in July and August 1997. A summary of these results, along with a copy of the research study plan, was included in the Annual Report for 1997 (www.werc.usgs.gov\pb\).

Cattle were turned out onto the newly fenced treatment plots for the first time in February 1998. The yearly plot, vegetation, and animal sampling schemes were completed as planned in 1998, and the cattle were removed in July 1998, just prior to mammal trapping. In 1999, a similar schedule was followed.

Results

Fire Effects: The 1997 wildfire only burned part of the study area, thus introducing a confounding factor into the study design. The unequal coverage of the fire was addressed by intentionally burning the remainder of the study area. The irony about the wildfire is that it probably would not have occurred without the abundant fuel provided by the exotic annual grasses. In addition, the fire probably would not have carried through the

study area if we had started our grazing a year earlier. The fires, however, have had considerable impacts on the study.

Still the most obvious and predictable effect of the fires was the death of virtually all the saltbush (*Atriplex* spp.) on the study site (See 1998 Annual Report). Few live saltbush remain within the fenced study area, but some seedling saltbushes are beginning to grow. However, the study area remains a grassland for the time being.

The effects of the fire in 1997 are lessening, but some effect still remains. The average of 30 RDM samples from each of the four control plots (ungrazed but burned) in August 1999 was 3,216 lbs/acre. This value is still lower than the 4,159 lbs/acre average from 30 samples taken from an ungrazed and unburned area immediately adjacent to and outside of the study area, but has increased considerably from the 2,439 lbs/acre recorded on the controls in 1998.

Rainfall: We put out two rain gauges at opposite ends of the study site in early November 1998. Although we missed a small weather event earlier in the Fall, the gauges recorded 229.8 mm (9.05 inches) and 221.4 mm (8.72 inches) total rainfall for the year (until 30 June 1999), more than 161.0 mm (6.34 inches) at Buttonwillow (about 11 km, or 7 mi, from the study site) but much less than the 412.5 mm (16.24 inches) recorded at Buttonwillow the preceding rainfall year. These totals are still more than the 20-year average of 168.9 mm (6.65 inches) from Buttonwillow. Significant amounts of rain fell from late November until late January, and in March and April. February was virtually dry.

Grazing Effects on Plots: As happened last year, the target RDM level of 500 lbs/acre was not reached, although a grazing effect on the treatment plots was achieved. The average stocking rate in 1999 was 1.39 AUM (Animal Units/Month) per acre on the four treatment plots, up from 0.71 AUM in 1998, but still cattle could not keep up with the growth of vegetation, and unfortunately the cattle operator simply could not obtain more cattle to further reduce the forage before the beginning of our mammal trapping in late July. The cattle were fairly equally distributed on the four treatment plots to achieve similar RDM levels, and this was fairly successful (Table 1). Additional cattle were put on Section 33 to try and remove the heavy growth of grass that accumulated on the southern half of the pasture (prescribed burned in 1997). Cattle tend to forage more on the northern half of the section, the part that was burned by wildlife in 1997. In addition to RDM, we also measured the height of vegetation, and cover (6 classes, lowest = least cover) on the plots. For RDM, there was a significant difference among plots (ANOVA, $F_{7, 239} = 17.28$, $P < 0.001$). The difference is explained by treatment plots having less RDM than controls. Similarly for height, treatment plots had shorter vegetation than controls (ANOVA, $F_{7, 239} = 13.21$, $P < 0.001$). There are significant differences among plots for cover (ANOVA, $F_{7, 239} = 9.34$, $P < 0.001$), but only three of the treatments have less cover than the controls (Table 1).

Table 1. *Cattle stocking rates and vegetation characteristics of study plots in 1999. Average cover determined by percentage cover classes (100%, 95%, 75%, 50%, 25%, 0%).*

Plots	Stocking Rates (AUM*)	RDM (lbs/acre)	Average Height (cm)	Average Cover (%)
21C	----	3081	34.9	93.5
21T	643	1225	21.8	83.7
27C	----	2722	35.5	93.2
27T	648	1464	24.8	73.8
29C	----	3076	33.5	93.2
29T	730	1274	24.8	83.6
33C	----	3987	37.3	100
33T	1156	1233	21.7	90.2

* 1 AUM = one cow weighing 1000 lbs for one month. Stocking rate is for the entire 1999 grazing season.

Vegetation Surveys: Data on Kern mallow reproduction and associated vegetation were collected 17 to 24 March 1999. Reproductive density of Kern mallow was at least an order of magnitude lower in 1999 than it had been in 1998 (Table 2), but did not differ between years statistically (Z = -1.75, 7 df, P = 0.08). In 1999, reproductive density in control plots (0.66 ± 0.62 SE) and treatment plots (0.82 ± 0.64 SE) did not differ (U = 7.0, X^2 = 0.10, 1 df, P = 0.76). Although mean reproductive density of Kern mallow had been higher in control plots (53.96 ± 53.92 SE) than treatment plots (22.78 ± 13.62 SE) in 1998, variability among sections was more pronounced, so the difference was not statistically significant (U = 8.0, X^2 = 0, 1 df, P = 1.00). Cattle grazing did not begin until the end of the growing season in 1998, so lower mallow densities on treatment plots did not represent a treatment effect.

The 1997 and 1998 reproductive density estimates differ from those presented in previous annual reports because desert mallow (*Eremalche exilis*) has been omitted from the data set used for this report. At the time of baseline sampling in 1997, *Eremalche* plants were too dry to be identified to species and thus the number of reproductive structures represented a combination of all *Eremalche* species present. Subsequent data have been collected during the flowering period when identification to species was possible, allowing estimation of reproductive density for Kern mallow alone. Considering the late initiation of grazing in 1998, Kern mallow reproductive densities from that year essentially represent pre-grazing conditions. Henceforth, 1998 will be treated as the baseline and combined estimates no longer will be reported. Desert mallow has not been observed in Section 21, and thus the 1997 estimate can reasonably be assumed to represent Kern mallow.

Table 2. *Reproductive density (mean ± SE) of Kern mallow (*Eremalche parryi *ssp.* kernensis*) on study plots by* year.

Plot	1997	1998	1999
21C	9.2 ± 3.9 (n = 20)	215.7 ± 47.0 (n = 55)	2.5 ± 1.0 (n = 22)
21T	12.7 ± 7.5 (n = 20)	46.5 ± 19.4 (n = 27)	0.6 ± 0.4
27C	N/A	0 (n = 10)	0.1 ± 0.1 (n = 10)
27T	N/A	0 (n = 10)	0 (n = 10)
29C	N/A	0.1 ± 0.1 (n = 10)	0 (n = 10)
29T	N/A	44.7 ± 22.0 (n = 11)	2.7 ± 1.1 (n = 22)
33C	N/A	0 (n = 10)	0 (n = 10)
33T	N/A	0 (n = 10)	0 (n = 10)
Overall	10.9 ± 1.8 (n = 2)	38.4 ± 26.4 (n = 8)	0.7 ± 0.4 (n = 8)

In general, the cover and species richness of vegetation were lower in 1999 than in 1998 (Table 3). Microbiotic crust cover did not differ significantly between years (Z = -0.47, 31 df, P = 0.64), but herbaceous plant cover (Z = -3.10, 31 df, P = 0.002) and the total number of species recorded on belt transects (Z = -3.83, 31 df, P < 0.001) were significantly lower in 1999 compared to 1998. In 1999, neither herbaceous cover (U = 151.0, X^2 = 0.75, 1 df, P = 0.39), microbiotic crust cover (U = 129.0, X^2 = 0.003, 1 df, P = 0.96), nor the total number of species recorded on belt transects (U = 91.5, X^2 = 1.91, 1 df, P = 0.17) differed between treatment and control plots. Percent total cover was identical to percent herbaceous cover for both 1998 and 1999 because shrub cover was absent. Some shrub seedlings, particularly spiny saltbush (*Atriplex spinifera*), had become established by 1999 but did not constitute measurable cover in vegetation transects.

Table 3. *Vegetation characteristics by year (mean ± SE, n_i = 4) on study plots*.

Plot	Percent herbaceous cover			Percent microbiotic crust cover			Number of species on belt		
	1997	1998	1999	1997	1998	1999	1997	1998	1999
21C	86.8 ± 1.4	91.8 ± 1.8	91.0 ± 2.1	1.3 ± 0.5	0	0	21.0 ± 0.6	22.5 ± 1.2	20.8 ± 0.5
21T	95.0 ± 1.7	93.3 ± 1.7	92.5 ± 2.7	0.5 ± 0.3	0	0	18.8 ± 1.4	19.0 ± 1.5	19.8 ± 1.0
27C	92.0 ± 1.5	93.3 ± 2.7	82.5 ± 6.9	1.3 ± 0.9	2.5 ± 2.2	1.8 ± 1.8	17.0 ± 1.1	20.3 ± 0.5	12.3 ± 2.1
27T	96.0 ± 1.1	86.3 ± 3.3	80.8 ± 4.8	3.8 ± 1.9	1.0 ± 0.4	1.0 ± 1.0	19.5 ± 1.4	18.0 ± 0.7	16.0 ± 0.4
29C	93.5 ± 0.5	91.0 ± 4.3	89.0 ± 3.8	5.3 ± 4.0	1.8 ± 1.2	1.0 ±0.7	13.3 ± 0.5	18.5 ± 0.5	9.8 ± 1.5
29T	97.0 ± 0.9	87.3 ± 2.7	78.8 ± 7.1	4.0 ± 4.0	0.3 ± 0.3	0.8 ± 0.5	17.5 ± 0.9	14.3 ± 2.2	13.3 ± 0.9
33C	99.5 ± 0.3	99.0 ± 0.4	96.5 ± 1.3	0	0	0	8.5 ± 1.5	16.0 ± 1.4	7.8 ± 0.6
33T	96.8 ± 0.9	97.3 ± 1.4	94.5 ± 2.6	0	0	0	12.3 ± 0.8	14.8 ± 1.3	10.0 ±1.4
Overall	94.6 ± 0.7	92.4 ± 1.1	88.2 ± 1.8	2.0 ± 0.7	0.7 ± 0.3	0.6 ± 0.3	16.0 ± 0.8	17.9 ± 0.6	13.7 ± 0.9

Red brome (*Bromus madritensis* ssp. *rubens*) increased in absolute cover from 1998 to 1999 ($Z = 4.92$, 31 df, $P < 0.001$), whereas red-stemmed filaree (*Erodium cicutarium*; $Z = -4.94$, 31 df, $P < 0.001$) and Arabian grass (*Schismus arabicus*; $Z = -4.08$, 31 df, $P < 0.001$) decreased and mouse-tail fescue (*Vulpia myuros*) did not change ($Z = 1.65$, 31 df, $P = 0.10$) (Table 4). Grazing prolonged the dominance of red-stemmed filaree, which achieved greater cover in treatment plots (30.6 ± 3.4 SE) than in control plots (9.88 ± 2.2 SE) during 1999 ($U = 25.0$, $X^2 = 15.10$, 1 df, $P < 0.001$). Grazing also delayed encroachment by red brome in treatment plots (47.3 ± 4.2 SE), with significantly higher cover present in control plots (68.3 ± 4.9 SE) during 1999 ($U = 199.5$, $X^2 = 7.27$, 1 df, $P = 0.007$). The pattern of domination remained the same for the other species between 1998 and 1999 (Table 4). Mean cover estimates from 1997 are available in previous annual reports.

Table 4. *Absolute cover of dominant species by year (mean ± SE, $n_i = 4$) on study plots*.

	Bromus madritensis ssp. *rubens*		*Erodium cicutarium*		*Schismus arabicus*		*Vulpia myuros*	
Plot	1998	1999	1998	1999	1998	1999	1998	1999
21C	16.5 ± 4.7	69.3 ± 2.5	83.8 ± 2.0	19.3 ± 4.2	3.3 ± 1.1	1.3 ± 0.5	5.3 ± 1.5	9.8 ± 2.4
21T	14.5 ± 5.0	33.3 ± 8.1	82.5 ± 5.4	46.8 ± 3.1	6.0 ± 2.1	3.8 ± 1.9	14.5 ± 2.5	47.3 ± 8.9
27C	10.5 ±1.8	41.0 ± 4.7	81.5 ± 3.7	13.3 ± 2.6	6.5 ± 2.1	6.3 ± 1.7	16.0 ± 2.3	44.0 ± 9.0
27T	18.5 ± 2.6	35.8 ± 0.3	60.3 ± 9.6	19.5 ± 1.0	17.5 ± 4.3	8.8 ± 4.0	22.5 ± 2.2	26.8 ± 8.1
29C	61.8 ± 3.9	87.0 ± 3.2	67.8 ± 12.1	1.0 ± 0.4	8.0 ± 2.2	0	7.0 ± 2.1	0.3 ± 0.3
29T	37.3 ± 5.0	61.8 ± 4.7	63.8 ± 9.1	20.5 ± 6.6	5.0 ± 1.8	0.3 ± 0.3	11.5 ± 2.9	9.3 ± 3.8
33C	55.0 ± 11.5	75.8 ± 7.7	81.3 ± 1.5	6.0 ± 2.6	4.0 ± 1.1	0	39.0 ± 9.1	31.8 ± 8.4
33T	47.8 ± 2.0	58.5 ± 6.2	66.0 ± 2.3	35.5 ± 3.0	7.0 ± 2.3	1.3 ± 0.8	37.3 ± 3.2	38.0 ± 4.5
Overall	32.7 ± 3.8	57.8 ± 3.7	73.3 ± 2.7	20.2 ± 2.7	7.2 ± 1.0	2.7 ± 0.8	19.1 ± 2.5	25.9 ± 3.6

The 1999 vegetation results are preliminary and must not be construed as representative of grazing effects. Data collection in future years will reveal whether there are long-term trends in Kern mallow abundance or vegetation relative to grazing.

Mammal Surveys: Numbers of nocturnal mammals increased greatly in 1999 on most plots in the study area. We caught 271 individual rodents across seven plots (Table 5). Most rodents captured were short-nosed kangaroo rats (*Dipodomys nitratoides brevinasus*) that were trapped abundantly on Section 27 (control and treatment). Also trapped relatively abundantly on most plots were San Joaquin pocket mice (*Perognathus i. inornatus*) and deer mice (*Peromyscus maniculatus*), and Heermann's kangaroo rats (*Dipodomys heermanni*) were caught frequently on Plot 29T (Table 5). In 1997, only 3 rodents (1 San Joaquin pocket mouse and 2 short-nosed kangaroo rats) were captured on 2 plots during the July/August 1997 trapping session in 6,912 trap-nights, and 43 rodents were caught across all plots in 1998 (see 1998 Annual Report).

We still are not at the point that we can carry out any meaningful statistical tests or draw any conclusions about nocturnal rodent numbers because of the low numbers of rodents, but we are encouraged that rodent populations are steadily increasing on the Lokern. We may start to see the effect of treatment, if any, on rodent numbers in the next few years as rodents reinvade our study site. Unfortunately, giant kangaroo rats (*Dipodomys ingens*) remain scarce on the Lokern. None were captured this year, although one capture was made last year on Plot 33T. A few active precincts occur in section 33, but no activity has been seen anywhere else in the study area.

Table 5. *Numbers of nocturnal mammals captured on study plots in 1999. All numbers are of individuals captured, except for* Peromyscus maniculatus, *which are total captures*.

	Number of Individuals Captured by Species*								
Plot	DH	DN	DI	PI	PM	OT	RM	MM	Total
21C	0	0	0	6	4	0	0	0	10
21T	0	7	0	12	3	0	0	0	22
27C	1	98	0	7	3	1	1	0	111
27T	0	65	0	8	4	0	0	1	78
29C	0	0	0	0	0	0	0	0	0
29T	6	11	0	4	17	0	0	0	38
33C	0	0	0	0	1	0	2	1	4
33T	0	0	0	2	6	0	0	0	8
Total	7	181	0	39	38	1	1	1	271

*DH = *Dipodomys heermanni*, Heermann's kangaroo rat
DI = *Dipodomys ingens*, giant kangaroo rat
DN = *Dipodomys nitratoides*, San Joaquin kangaroo rat
PI = *Perognathus inornatus*, San Joaquin pocket mouse
OT = *Onychomys torridus*, southern grasshopper mouse
PM = *Peromyscus maniculatus*, deer mouse
RM = *Reithrodontomys megalotus*, western harvest mouse
MM = *Mus musculus*, house mouse

The number of San Joaquin antelope squirrels (*Ammospermophilus nelsoni*) caught in 1999 increased from 1998, and numbers generally increased substantially on the treatment plots, but were static or declining on the control plots (Table 6). In 1997 and 1998, antelope squirrels were as abundant on the control plots as the treatment plots (perhaps an
effect of fire disturbance), but squirrels were captured in substantially higher numbers on treatment plots than on controls in 1999 (Table 6). Control plots have a much denser cover of grass than treatment plots. No squirrels have been caught in two years on Plot 29C, which is one of the most densely grass-covered controls.

Table 6. *Number of individual San Joaquin antelope squirrels captured on study plots by year*.

Plot	1997	1998	1999
21C	4	5	2
21T	9	2	5
27C	3	8	2
27T	4	2	15
29C	5	0	0
29T	1	2	6
33C	6	5	7
33T	5	9	23

Bird Studies: On point counts in 1999, horned larks (*Eremophila alpestris*), sage sparrows (*Amphispiza belli*), and western meadowlarks (*Sturnella neglecta*) were the most often detected species in the study area (Table 7), as in 1998. Unlike the past two years, savannah sparrows (*Passerculus sandwichensis*) were detected often on point count plots in 1999 (Table 8). Numbers of savannah sparrows and western meadowlarks have steadily increased in the past three years, and with no difference between control or treatment plots. Numbers of sage sparrows have steadily decreased since the fire in 1997. Horned larks increased in numbers in 1998 from 1997, and numbers in 1999 were similar to 1998 (Table 8). Horned larks were found substantially more often on point count plots in 1999 in treatment areas. Other species were detected rarely, and were not clearly related to either the burn or treatment.

Table 7. *Average point count values for each bird species for 1999*.

Species	21C	21T	27C	27T	29C	29T	33C	33T
BUOW	0	0	0	0	0.5	0	0	0
HOLA	1.0	1.25	0	2.75	0.25	3.5	0	2.25
LOSH	0	0	0	0	0	0	0.25	0
MODO	0.25	0	0	0	0.25	0	0	0
SAGSP	1.5	0.5	1.75	1.75	0.25	0	0.25	0.25
SAVSP*	2.25	0.25	5.25	1.75	0.25	0	0	2.75
WEME	2.0	2.0	3.0	2.75	2.25	1.5	3.0	2.5

* Breeding unlikely. BUOW, Burrowing Owl; HOLA, Horned Lark; LOSH, Loggerhead Shrike; MODO, Mourning Dove; SAGSP, Sage Sparrow; SAVSP, Savannah Sparrow; WEME, Western Meadowlark.

Table 8. *Average (standard deviation) point count values for birds by year and plot*.

	1997		1998		1999	
Species	Control	Treatment	Control	Treatment	Control	Treatment
BRBL	0	0	0.06 (0.13)	0	0	0
BUOW	0	0	0	0	0.13 (0.25)	0
CORA	0	0	0	0.06 (0.13)	0	0
HOLA	0.19 (0.24)	0.06 (0.13)	0.5 (0.68)	2.25 (0.87)	0.31 (0.47)	2.44 (0.94)
LOSH	0	0	0	0	0.06 (0.13)	0
MODO	0.06 (0.13)	0.06 (0.13)	0.25 (0.35)	0	0.13(0.14)	0
RWBL	0	0	0.5 (0.58)	0	0	0
SAGSP	2.38 (1.51)	2.13 (1.16)	1.5 (1.24)	1.69 (1.42)	0.94 (0.80)	0.63 (0.78)
SAVSP*	0	0	0.63 (0.32)	0.19 (0.24)	1.94 (2.43)	1.19 (1.30)
TRBL*	0	0	0.06 (0.13)	0	0	0
WCSP*	0	0	0.94 (1.09)	0.06 (0.13)	0	0
WEME	0.69 (0.31)	1.06 (0.55)	1.31 (0.85)	0.85 (0.72)	2.56 (0.52)	2.19 (0.55)

* Breeding unlikely. BRBL, Brewer's Blackbird; BUOW, Burrowing Owl; CORA, Common Raven; HOLA, Horned Lark; LOSH, Loggerhead Shrike; MODO, Mourning Dove; RWBL, Red-winged Blackbird; SAGSP, Sage Sparrow; TRBL, Tricolored Blackbird; WCSP, White-crowned Sparrow; WEME, Western Meadowlark.

Birds detected in point count plots mainly are breeding in the study area. Birds have also been counted that have been detected flying over point count plots, but could not be considered to be within point count detection area. This category shows species that are making some use of the study area, but may not breed on site. This count shows that a few more species make use of the area than are found on point count plots, especially common ravens (Table 9).

Table 9. *Total counts of birds observed flying over point count plots.*

Species	1997		1998		1999	
	Control	Treatment	Control	Treatment	Control	Treatment
Brewer's Blackbird	0	0	0	2	0	2
Brown-headed Cowbird	0	0	4	0	0	0
Cliff Swallow	0	0	2	2	0	1
Common Raven	1	10	0	10	6	1
European Starling	0	2	3	1	0	0
Horned Lark	4	5	0	1	0	0
Loggerhead Shrike	1	0	1	0	0	0
Long-billed Curlew*	0	0	0	1	0	0
Mourning Dove	1	3	3	0	0	2
Northern Mockingbird	1	0	0	0	0	0
Northern Rough-winged Swallow	0	0	2	0	0	0
Red-winged Blackbird	5	0	3	0	0	0
Sage Sparrow	1	0	0	0	0	0
Tricolored Blackbird*	0	0	0	9	0	0
Unknown Blackbird Species	0	0	0	0	0	4
Western Meadowlark	0	1	0	0	1	1
White-crowned Sparrow*	0	0	0	1	0	0

* Breeding Unlikely.

Another census method used in this study to detect birds was to record species found within a 300 X 300 m area beyond point count plots. This method should add larger species of birds to the list because the area of detection is larger than the other two census methods. However, these larger species do not necessarily breeding on site, such as the common raven (*Corvus corax*, Table 10).

Table 10. *Number of times a species was detected within a 300 X 300 m area (out of a possible 16 per treatment per year), but not in point count plots.*

Species	1997		1998		1999	
	Control	Treatment	Control	Treatment	Control	Treatment
American Kestrel	1	0	0	0	0	0
American Crow*	0	0	0	0	1	0
Black-headed Grosbeak*	0	1	0	0	0	0
Brewer's Blackbird	0	0	1	1	0	1
Brown-headed Cowbird	0	0	0	1	0	0
Burrowing Owl	0	1	0	0	0	0
Cliff Swallow	1	2	0	1	0	0
Common Raven	9	6	6	6	6	10
European Starling	0	0	0	1	0	0
Horned Lark	4	3	3	0	4	3
Killdeer	0	0	0	1	0	0
Le Conte's Thrasher	6	6	0	0	0	0
Lesser Nighthawk	0	0	0	1	0	0
Loggerhead Shrike	7	7	1	1	5	1
Long-billed Curlew*	0	0	1	4	1	1
Mourning Dove	6	6	3	2	3	1
Northern Mockingbird	3	0	1	1	0	0
Northern Harrier	0	0	0	1	0	0
Prairie Falcon	0	0	0	0	1	0
Red-winged Blackbird	0	0	1	0	0	0
Sage Sparrow	1	1	1	1	1	0
Sage Thrasher*	0	1	0	0	0	0
Savannah Sparrow*	0	0	0	0	0	1
Tricolored Blackbird*	0	0	1	0	0	1
Unknown Blackbird Species	0	0	0	0	0	1
Unknown Hummingbird Species	1	0	0	0	0	0
Western Kingbird	0	0	1	1	0	0
Western Meadowlark	7	6	6	6	2	5
White-crowned Sparrow*	0	0	0	0	1	0

* Breeding Unlikely.

Lizard Surveys: Numbers of lizards remain extremely low on all plots (Table 11). Blunt-nosed leopard lizards (*Gambelia sila*), in particular, have not rebounded from their low numbers in 1998. We did find two leopard lizards within the first three censuses on Plot 27T, but no other leopard lizards were found during the rest of the census of this plot. Encouragingly, though, one leopard lizard on this plot was an adult male in breeding colors, and the other was an adult female carrying 4 eggs. Four of the five leopard lizards seen during censuses were found on treatment plots. As in past years, no leopard lizards were seen during extensive walking on the plots during mammal trapping in July and August. Side-blotched lizards (*Uta stansburiana*) were found more abundantly during censusing this year than in 1998, but their numbers are still low. Western whiptail lizards (*Cnemidophorus tigris*) were found in about the same numbers in 1998 and 1999.

Table 11. *Number of lizards counted on the study plots by year*.

	Species* Numbers by Year								
	BNLL			SBL			WWL		
Plot	1997	1998	1999	1997	1998	1999	1997	1998	1999
21C	4	1	1	3	2	0	1	7	0
21T	2	0	0	5	2	1	1	10	7
27C	1	0	0	5	2	5	1	4	5
27T	3	0	2	3	0	11	5	16	14
29C	3	0	0	2	0	1	2	1	7
29T	0	2	1	3	2	10	2	2	4
33C	0	0	0	1	0	0	0	1	0
33T	1	0	1	5	0	0	1	0	1
Totals	14	3	5	25	9	28	13	41	38

* BNLL = Blunt-nosed leopard lizard, *Gambelia sila*
SBL = Side-blotched lizard, *Uta stansburiana*
WWL = Western whiptail lizard, *Cnemidophorus tigris*

Mean number of grasshoppers counted per day during censuses for lizards were much lower in 1999 than in 1998 (Table 12), although means were not as low as during 1997 (which was just after the wildfire). Unlike in 1998, when mean numbers were

consistently greater on the grazed (treatment) plots than on the ungrazed control plots, no differences were found between plots in 1999 (Table 12).

Table 12. *Grasshopper numbers (± standard deviation) counted on plots during surveys for blunt-nosed leopard lizards*.

	Average Number Counted Per Day		
Plot	1997	1998	1999
21C	5.2 (± 4.85)	611.2 (± 563.1)	69.4 (± 68.33)
21T	6.4 (± 6.62)	654.4 (± 437.9)	77.4 (± 59.66)
27C	4.3 (± 3.40)	139.6 (± 50.35)	54.1 (± 53.98)
27T	4.9 (± 4.70)	192.0 (± 64.96)	211.2 (± 189.5)
29C	10.6 (± 5.15)	136.7 (± 130.9)	329.5 (± 248.2)
29T	11.9 (± 7.84)	473.8 (± 475.8)	39.1 (± 15.44)
33C	11.2 (± 12.8)	55.3 (± 53.11)	27.1 (± 12.21)
33T	12.7 (± 11.1)	131.0 (± 114.6)	65.6 (± 36.28)

Invertebrate studies: Terrestrial invertebrates were sampled with arrays of ten pitfalls on each of the eight plots, as in 1997 and 1998 (see Annual Report for 1997). These traps were monitored during the same six days that mammals were trapped in July/August of both years. The average number of invertebrates found per day in pitfall traps decreased markedly from 1998, and was lower than 1997 (Table 13). There was a difference among plots (ANOVA, $F_{7, 47} = 9.15$, $P < 0.0001$), with plot 21T having significantly higher numbers of invertebrates than all but 27C.

Table 13. *Average number of invertebrates/pitfall/day on study plots by year*.

Plots	1997	1998	1999
21C	3.9	11.1	1.3
21T	4.2	15.0	4.7
27C	4.2	24.7	2.9
27T	3.9	9.4	1.3
29C	5.0	5.8	1.5
29T	12.9	7.4	1.8
33C	4.5	5.8	1.4

33T	4.4	21.8	1.3

More terrestrial vertebrates were captured in pitfall traps in 1999 than in previous years. In 1997, one side-blotched lizard and five whiptail lizards were caught, while in 1998 the pitfalls yielded one San Joaquin pocket mouse, 10 side-blotched lizards, and 13 whiptails. In 1999, we found 19 San Joaquin pocket mice, 3 deer mice, 4 side-blotched lizards, 8 and whiptails.

There are several reasons why the capture results for terrestrial vertebrates should be examined with caution, and conclusions drawn sparingly this early in the study. First, it will take another year or two for the major effects of the fires on RDM to disappear on the control plots. Secondly, because of relatively low reproductive rates there is an inevitable lag time for these populations to respond to environmental changes – including grazing. Thirdly, the populations certainly respond to more environmental variables than just grazing, and it will require several years of monitoring relative numbers in the different plots to begin to understand these factors.

Funding

We have successfully raised nearly $150,000 in cash to prepare the study site for the research, and to implement plant and animal sampling in 1997-2000. This figure does not include nearly an equal amount of in-kind contributions from cooperators. It costs about $65,000 in cash per year (see below) to maintain the study site and carry out the sampling, which does not include on-going commitments for in-kind support. At present, we have funds to cover costs through 2000. We do not yet have sufficient funds for 2001 and beyond. As in the past, we will be relying on contributions from all of the participants to meet future funding needs.

Yearly Budget (Does not include in-kind contributions):

Item	Cash Amount
CA State Univ. Bakersfield Foundation	$35,000
End. Sp. Recov. Prog. Plant Studies	$15,000
WERC, Kern Field Stn	$7,000
Vehicle	$3,000
Travel	$3,000
Field Supplies/Repairs	$2,000
Total	$65,000

Cooperators

The Bureau of Land Management (BLM) has been the principal “client” of the Lokern Project, and their needs have driven much of the planning and design of the study.

Numerous other agencies and organizations have realized that the research has broad applicability to their lands and interests, and they have participated in various aspects of the project.

In addition to WERC and BLM, the main supporters and participants in the Lokern Project include the Endangered Species Recovery Program (ESRP); the US Fish and Wildlife Service (USFWS); the California Department of Fish and Game (CDFG); the California State University, Bakersfield (CSUB); the Center for Natural Lands Management (CNLM); the California Department of Water Resources (CDWR); Chevron Oil Company; ARCO Oil Company; Occidental of Elk Hills, Inc.; Safety Kleen Environmental Services; and Eureka Livestock Company.

The following investigators have been responsible for implementing the different aspects of the Lokern research. These scientists have also contributed summaries of data for this annual report:

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Dr. David Germano, Research Biologist, Department of Biology, California State University, Bakersfield, CA 93311-1099. Phone 661/589-7846. Dgermano@csubak.edu. ***Lizard, mammal, and invertebrate studies. Report coordination and preparation.***

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